

LAB 2002

SERVICE MANUAL

1999 EMC

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LAB 2002

Theory of function

Power supply

AC-power is coming in to terminal K1. The voltage is rectified by D1 and filtered by C10, C11. This gives 310V DC to the transformer TR1. The PWM-controller U1 controls the switch Q1-Q3 to give the correct output voltage at terminal J17, J19. When the switch Q1-Q3 is closed, current flows through transformer, TR1, storing energy. Because of the voltage polarity, diode D3, D4 are reverse-biased, thus no voltage present at the load. When the switch is open, transformer TR1 reverses polarity because of the collapsing magnetic field, forward-biasing diode D3, D4, and inducing a current flow into the capacitors C12, C14. The reversed voltage is sensed by a winding in TR1 and rectified by diode D8. The PWM-controller adjusts the on-time of the switch, by comparing the voltage across C14 with an internal reference, to give a rail voltage of $\pm 155V$ across the capacitors C12, C14. The voltage can be adjusted by potentiometer TP2. The maximum current in the transformer is sensed over the resistor R6-R8. The voltage across R6-R8 is compared with a reference-voltage, set by TP3, which makes it possible to adjust the maximum output power from the power supply. Normally TP3 is in maximum position, but if something has to be repaired in the amplifier, TP3 is used for "slow starting" the amplifier.

Amplifier

The input signal is connected to the balanced amplifier U1. The gain in this amplifier can be reduced by opto resistor LDR1 to prevent clipping in the output amplifier. From amplifier U1 signal is going to limiter U2, Q1, Q2 passing gain control P1. This limiter together with the phase linear lowpassfilter U3, U4 limits the slewrate of the signal going to the output amplifier 4KLF, preventing from intermodulation in this amplifier if signals of too high frequencies are presented on the input terminal.

The output amplifier 4KLF works as an ordinary power amplifier with the difference that the collector voltage to the output transistors is supplied from the switch mode amplifier 4KHF.

The base voltage on the output transistors Q26-Q28, Q31-Q33 is sensed by voltage divider R36-R38 and is then sent to the adjustable limiter U3, U4 on the input board, before it reaches the input on the switch mode amplifier. Limit level is set by the minimum load select-switches (MLS-sv.) to give correct output power in different loads. These switches also change the sensitivity for the led bars on the front panel.

The amplifier U1 (U2) on the HF-board makes sure that the output signal on terminal J4 (J8) is a copy of the input signal on terminal J12, by giving correct control voltage to pulse width modulator U3. U3 compares this voltage with an 614Khz triangular wave giving a pulse wide modulated output signal from Q1 (Q7) which is filtered by L1, C1 (L4, C10). The gain from the base of the output transistors in the LF-amplifier to the output of the HF-amplifier is equal to one. TP1 (TP2) is used to add a DC-offset on the input of U1 (U2) giving +7,5V (J4) -7,5V (J8) relative output of the LF-amplifier (J6), which is the same as collector-emitter voltage for the output transistors Q26-Q28, Q31-Q33.

REPAIRING INSTRUCTIONS

REQUIRED MEASUREMENT EQUIPMENT:

- Audio generator
- AC-voltmeter/THD-meter
- 2 digital voltmeters
- Two channel oscilloscope for audio
- Variac 0-280V, 6A
- 50Mhz oscilloscope, ex. Tek 2225
- with 100x probe ex. Tek P6009

AMPLIFIER

1. Without changing any fuses check the power supply +136V, -136V, +16V, -16V, +30V. If these aren't OK go to section for repairing power supply.
2. If all fuses are OK, follow the signal from input to output, and repair in normal way. The best way is to place the amplifier on the front handles, loosen the rear panel, and mount it back on distances (delivered with this manual) to make it possible to measure.
3. If there is a fault in the power amplifier stage do as follows:
 - 3:1 Turn TP1, TP2 on the HF-board, TP3 on the power supply board counter clockwise.
 - 3:2 Short-circuit R38 on LF-board.
 - 3:3 Disconnect cables from Q28, and Q32 collectors on the LF-board.
 - 3:4 Replace broken fuses. (only for the channel you repair)
 - 3:5 Connect DC-voltmeter (200V) to the positive (negative) rail voltage.
 - 3:6 Connect another DC-voltmeter (20V) to the cable disconnected from Q28 (Q32).
 - 3:7 Turn TP3 (PSU) slowly clockwise, TP1 and watch the voltmeters. Rail voltage should increase rapidly, "collector voltage" should read 0. After turning TP3 maximum 30°, rail voltage should be 136V.
 - a. If the rail voltage is zero or very low, check Q1, D1 (Q7, D5) (shorted) on the HF-board..
If Q1 (Q7) is broken, also replace R3 (R16) and D2 (D6).
 - b. If OK (155V) turn TP1 (TP2) slowly maximum clockwise. Voltage measured on the disconnected collector cable should stop at about 7,5V.

c. If OK turn TP1 (TP2) and TP3 counter clockwise.

3:8 Repeat from 3:5 for the negative side (xx).

3:9 Reconnect cable to Q28 collector.

3:10 Connect dummy load 16Ω to output, and connect an oscilloscope (10V/div) across the load.

3:11 Slowly turn TP3 (PSU) for 136V (-136V) rail voltage.

3:12 Slowly turn TP1 (TP2) clockwise and look at the oscilloscope. There should be no DC on the oscilloscope. If there is DC ($\leq 1V$) repair the positive (negative) output section on the LF-board.

3:13 Turn back TP1 (TP2) and TP3, and disconnect Q28 collector.

3:14 Reconnect Q32 collector and repeat from 3:11 for the negative side.

3:15 Reconnect cables to Q28 and Q32 collector. Turn TP3 for 136V rail voltage. Turn TP1 clockwise, no DC on the oscilloscope. Then slowly turn TP2 clockwise. There can be some oscillation with TP2 in middle position, but it will stop at further turning.

3:16 Connect 1KHz sine wave to the input of the amplifier. Adjust gain until there is signal on the output. It should be a 7V PK sine wave with no distortion.

3:17 Disconnect short circuit from R38, and the amplifier will work.

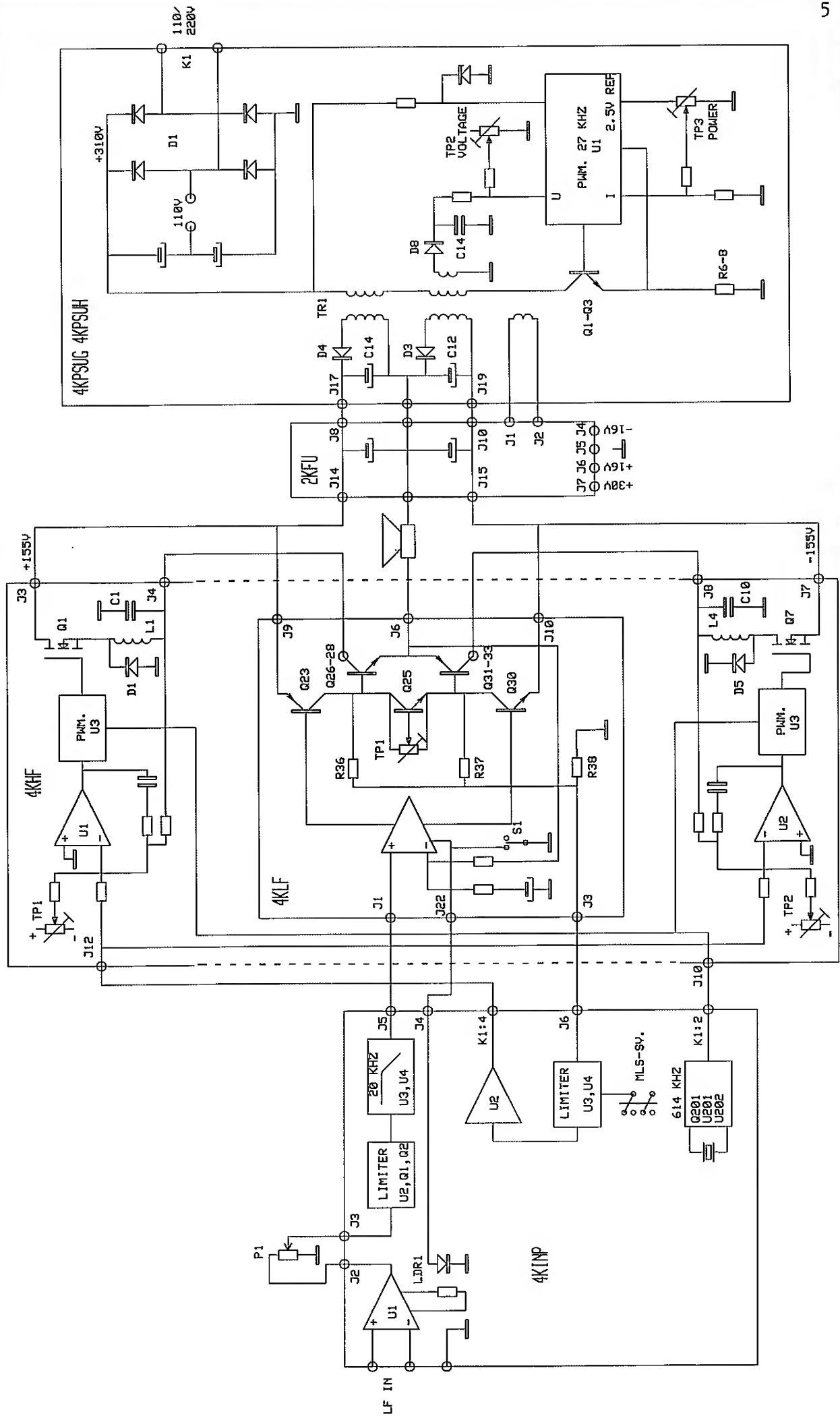
POWER SUPPLY

Required measurement equipment	-Isolation transformer for the mains, 1:1
-Audio generator	-Variac 0-280V, 6A
-DVM	(-Two channel oscilloscope for audio)
-50 MHz oscilloscope, ex. Tek 2225	(-AC Voltmeter/ THD-meter)
with 100x probe ex. Tek P6009	

- 1) Turn TP2 and TP3 fully counter clockwise.
- 2) Change F1 on the PSUG.
- 3) Increase the main voltage slowly by the variac.
- 4) Measure the voltage across C1 on PSUH.
 - a) No voltage: -change R1 PSUG.
 - b) The current increases quickly: -check D1- PSUG-check Q1, Q2, Q3 PSUH.
- 5) It is now possible to increase the voltage across C1 on PSUH to approx. 300 V without current inrush.

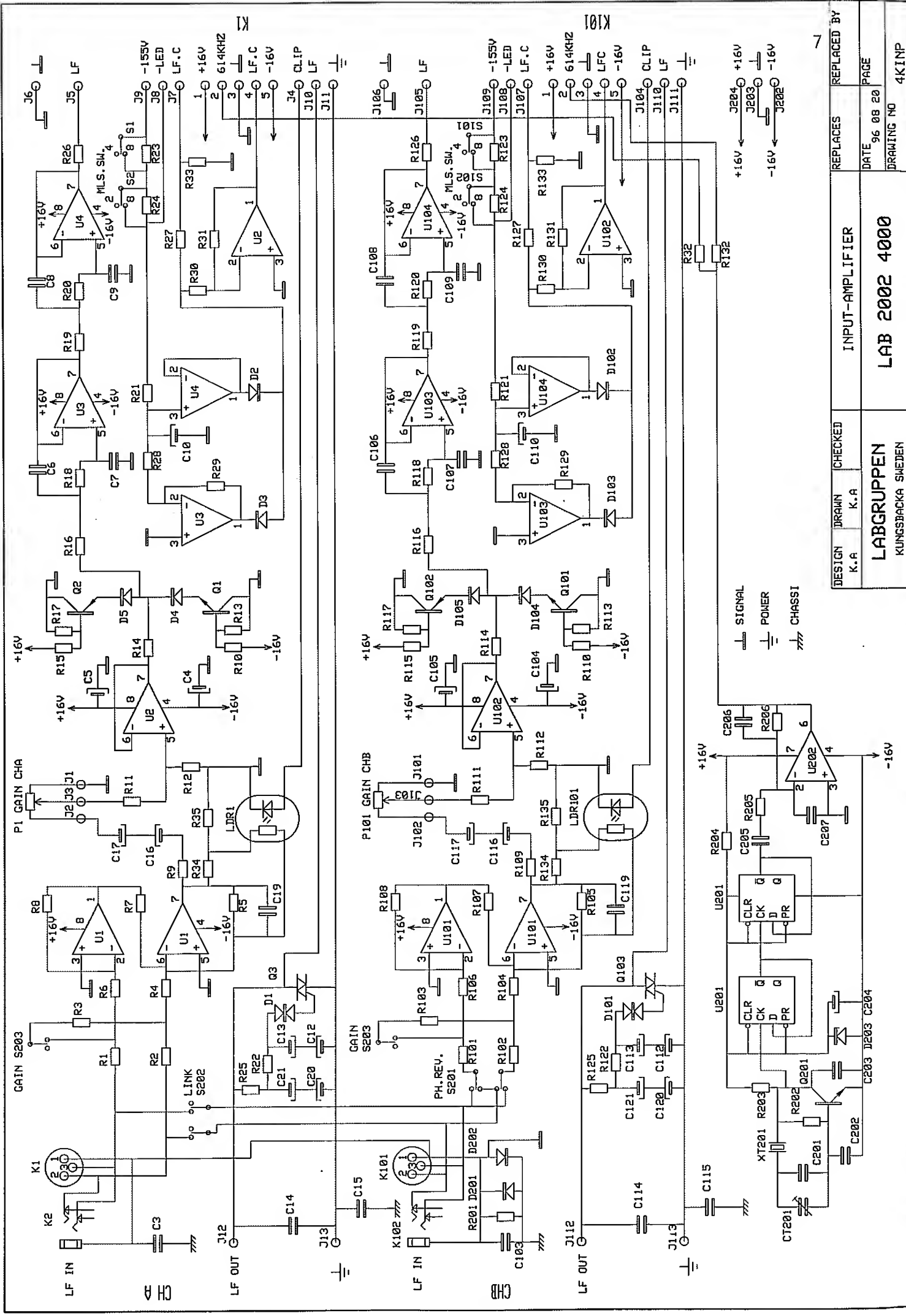
- 6) Connect an oscilloscope to mains voltage via an isolation transformer.
Then measure across Q1 collector and emitter.
- 7) Turn TP3 slowly clockwise until a pulse is visible on the scope. The frequency is approx. 27 kHz (see figure1). If the graph is seen, go to item 9).
- 8) If nothing is seen check:
 - a) U1:15 > 14V
 - b) U1:16 5V
 - c) U1:3 < 3V
 - d) U1:2 > 3V
 - e) U1:8 > 5V
 - f) U1:10 54KHz ramp
- 8) If only narrow spikes are seen, check the following components.
 - a) D3, D4 - PSUH or the output circuits.
 - b) D1, D2 - makes U1 goes into over voltage protection.
- 9) Turn TP3 fully clockwise:
 - a) Check the output voltage on C22, C23 – PSUG for correct voltage.
Adjust with TP2. Correct voltage is found in the schematics (see below).
 - b) Check the soft start circuit by turn on and off the main switch and look at the oscilloscope.
 - c) Increase the power by applying an audio signal to the amplifier and turn up the gain controls. -The pulse width will increase.
 - d) Check the over/ under voltage protection circuits by turning the variac up to 280 VAC and down to 130 VAC. (No load).

Fig. 1

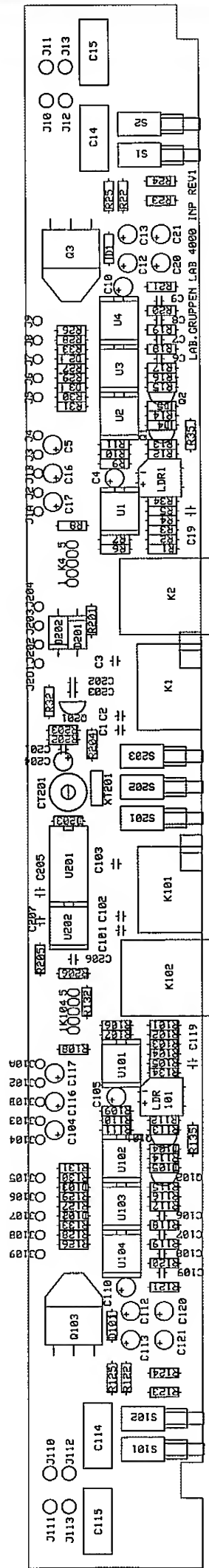


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DESIGN	DRAWN	CHECKED	THEORI OF FUNCTION	REPLACES	REPLACED BY
K.A	K.A	K.A	LAB 2002 4000		
LABGRUPPEN			DATE	PAGE	
KUNGSBACKA SWEDEN			96 08 20	20	
			DRAWING NO		4KFUN



DESIGN	DRAWN	CHECKED	INPUT-AMPLIFIER	REPLACES	REPLACED BY
K.A.	K.A.				
LABGRUPPEN			LAB 2002 4000		
KUNGSBACKA SWEDEN			DATE 96 08 20		
			DRAWING NO 4KINP		



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DESIGN	DRAWN	CHECKED	REPLACES	REPLACED BY
K.A.	K.A.			
LABGRUPPEN			INPUT AMPLIFIER	
KUNGSBACKA SWEDEN			LAB2002 LAB 4000	
			DATE	PAGE
			99 09 18	
			DRAWING NO	4KINPR1-P

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INPUT AMPLIFIER AND INTERNAL CONNECTIONS

Component-list

LAB 2002 INPUT AMPLIFIER

Component-list Channel A

(Ch. B; add 100, Ch. A+B add 200)

Resistors

R1	10 k Ω 1%
R2	10 k Ω 1%
R3	5,36 k Ω 1% 29 dB gain
R3	9,76 k Ω 1% 32 dB gain
R4	10 k Ω 1%
R5	66 k Ω 1%
R6	10 k Ω 1%
R7	22 k Ω 1%
R8	22 k Ω 1%
R9	100 Ω
R10	47 k Ω 1%
R11	1 k Ω 1%
R12	47 k Ω 1%
R13	18 k Ω 1%
R14	1 k Ω 1%
R15	47 k Ω 1%
R16	10 k Ω 1%
R17	18 k Ω 1%
R18	10 k Ω 1%
R19	10 k Ω 1%
R20	10 k Ω 1%
R21	715 k Ω 1%
R22	27 k Ω 1%
R23	2,4 k Ω 1% long legs
R24	6,2 k Ω 1W long legs
R25	27 k Ω 1%
R26	100 Ω
R27	10 k Ω 1%
R28	47 k Ω 1%
R29	47 k Ω 1%
R30	10 k Ω 1%
R31	10 k Ω 1%
R32	100 Ω
R33	12,4 k Ω 1%
R34	10 k Ω 1%
R35	1 k Ω 1%
R36	47 k Ω 1%

Optoresistor

LDR1 VTL5C4

Transistors

Q1	BC 547
Q2	BC 557
Q3	Q 4015R6

Capacitors

C1	-
C2	-
C3	330 nF 50V
C4	10 μ F 50V
C5	10 μ F 50V
C6	220 pF 5%
C7	220 pF 5%
C8	330 pF 5%
C9	100 pF 5%
C10	0.47 μ F 50V
C11	-
C12	22 μ F 50V
C13	22 μ F 50V
C14	0.47 μ F 250V
C15	2.2 μ F 63V
C16	22 μ F 50V
C17	22 μ F 50V
C18	-
C19	22 pF
C20	22 uF 50V
C21	22 uF 50V

Diodes

D1	DB 3
D2	1N 4148
D3	1N 4148
D4	1N 4148
D5	1N 4148

Switches

S1	Alps SPPJ3
S2	Alps "

Integrated circuits

U1	NE 5532
U2	NE 5532
U3	LF 353
U4	LF 353

Connectors

K1	3-pole XLR chassie
K2	3-pole Telejack
K4	5-pole pinheader

Resistors

R201	10 Ω
R202	220 k Ω
R203	1 k Ω 1%
R204	2.2 k Ω
R205	2,2 k Ω 1%
R206	22 k Ω 1%

Capacitors

C201	22 pF
C202	220 pF
C203	68 pF
C204	10 μ F 25V
C205	1 nF
C206	68 pF 5%
C207	220 pF

Trim capacitors

CT201 2-22pF

Diodes

D201	1N 5404
D202	1N 5404
D203	5.6V Zener 2%

Transistors

Q201 BC 547

Integrated circuits

U201	74HC74
U202	LM 318

Crystals

X201 2,4576 mHz

Switches

S201	Alps SPPJ3
S202	Alps "
S203	Alps "

INTERNAL CONNECTIONS

RA	10 k Ω 1%
P1	10 k Ω lin Tokos
K3	Speak-on NL-4MP

Inductors

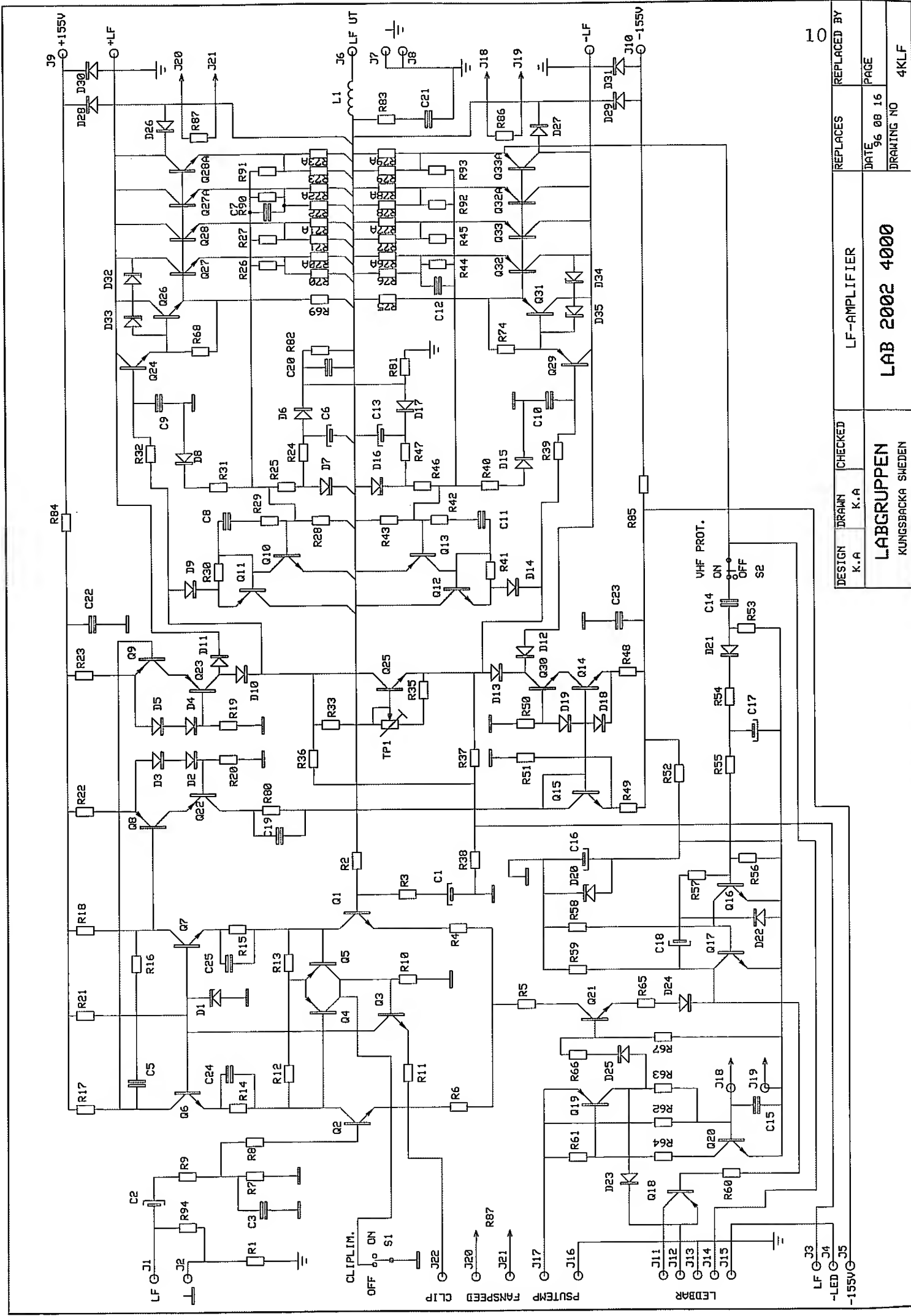
L1 9.5 μ H (2 core)
L2 9.5 μ H (2 core)

***Until 9902**

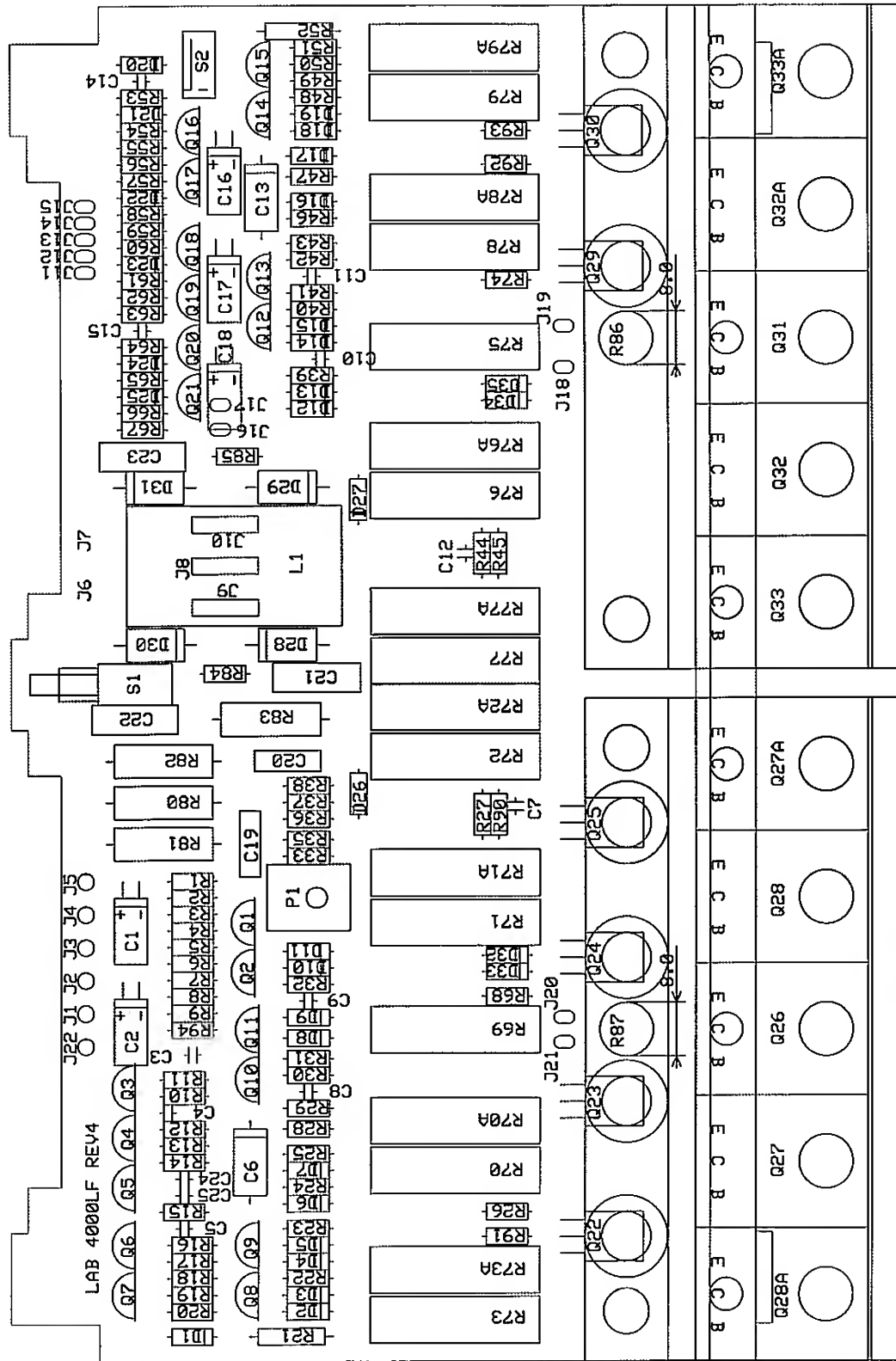
C6 470pF 5%
C7 470pF 5%
C8 680pF 5%
C9 220pF 5%

***Until 2001-06**

D1 HS10
R22 47 k Ω 1%
R25 47 k Ω 1%



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K.A.	K.A.	K.A.	LF-AMPLIFIER	
LAB 2002 4000				
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96 08 16			4KLF	



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K.A	K.A			
LABGRUPPEN			LAB2002 LAB4000	
KUNGSBACKA SWEDEN			DATE 99 09 18	
			DRAWING NO 4KLF4-P	

LAB 2002

LF-AMPLIFIER

Component-list

Resistors

R1	10 Ω
R2	27 k Ω 1%
R3	1 k Ω 1%
R4	180 Ω 1%
R5	1.8 k Ω 1%
R6	180 Ω 1%
R7	27 k Ω 1%
R8	10 Ω
R9	1 k Ω 1%
R10	100 k Ω 1%
R11	1.8 k Ω 1%
R12	27 k Ω 1%
R13	27 k Ω 1%
R14	3.3 k Ω 1%
R15	3.3 k Ω 1%
R16	4.7 k Ω 1%
R17	3.3 k Ω 1%
R18	3.3 k Ω 1%
R19	100 k Ω 1%
R20	100 k Ω 1%
R21	18 k Ω 2W
R22	100 Ω 1%
R23	100 Ω 1%
R24	27 k Ω 1%
R25	68 k Ω 1%
R26	-
R27	12,4 k Ω 1%
R28	3.9 k Ω 1%
R29	10 k Ω 1%
R30	4.7 k Ω 1%
R31	560 k Ω 1%
R32	220 Ω
R33	3.3 k Ω 1%
R34	-
R35	604 Ω 1%
R36	100 k Ω 1% 0.7W
R37	100 k Ω 1% 0.7W
R38	820 k Ω
R39	220 Ω
R40	560 k Ω 1%
R41	4.7 k Ω 1%
R42	10 k Ω 1%
R43	3.9 k Ω 1%
R44	12.7 k Ω 1%
R45	12.7 k Ω 1%
R46	68 k Ω 1%
R47	27 k Ω 1%
R48	100 Ω 1%
R49	100 Ω 1%
R50	100 k Ω 1%
R51	100 k Ω 1%
R52	18 k Ω 2W
R53	10 k Ω 1%
R54	10 k Ω 1%
R55	220 k Ω 1%

R56	100 k Ω 1%
R57	220 k Ω 1%
R58	56 k Ω 1%
R59	56 k Ω 1%
R60	27 k Ω 1%
R61	3.3 k Ω 1%
R62	432 k Ω 1%
R63	2.2 M Ω
R64	27 k Ω 1%
R65	2.7 k Ω 1%
R66	100 k Ω 1%
R67	56 k Ω 1%
R68	47 Ω
R69	4.7 Ω 5W
R70	-
R70a	-
R71	0.27 Ω 5W
R71a	0.27 Ω 5W
R72	0.27 Ω 5W
R72a	0.27 Ω 5W
R73	0.27 Ω 5W
R73a	0.27 Ω 5W
R74	47 Ω
R75	4.7 Ω 5W
R76	0.27 Ω 5W
R76a	0.27 Ω 5W
R77	0.27 Ω 5W
R77a	0.27 Ω 5W
R78	-
R78a	-
R79	0.27 Ω 5W
R79a	0.27 Ω 5W
R80	6.8 k Ω 3W
R81	820 Ω 6W
R82	1.5 k Ω 3W
R83	10 Ω 3W
R84	10 Ω
R85	10 Ω
R86	150 k Ω NTC
R87	150 k Ω NTC
R88	-
R89	-
R90	12.4 k Ω 1%
R91	12.4 k Ω 1%
R92	-
R93	12.4 k Ω 1%
R94	27 k Ω 1%

Trim potentiometers

TP1	250 Ω
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Capacitors

C1	220 μ F 16V
C2	10 μ F 50V
C3	150 pF ker
C4	-

C5	680 pF
C6	1 μ F 100V
C7	1 nF 63V
C8	1 nF 63V
C9	680 pF
C10	680 pF
C11	1 nF 63V
C12	1 nF 63V
C13	1 μ F 100V
C14	39 pF 500V
C15	0.1 μ F 40V
C16	220 μ F 16V
C17	4.7 μ F 50V
C18	10 μ F 50V
C19	22 nF 250V
C20	47 nF 250V
C21	0.1 μ F 250V
C22	0.1 μ F 250V
C23	0.1 μ F 250V
C24	4.7 nF
C25	4.7 nF
C26	-
C27	-

Diodes

D1	15 V Zener
D2	1N 4148
D3	1N 4148
D4	1N 4148
D5	1N 4148
D6	1N 4004
D7	27 V Zener
D8	BAV 21
D9	1N 4148
D10	1N 4148
D11	BAV 21
D12	BAV 21
D13	1N 4148
D14	1N 4148
D15	BAV 21
D16	27 V Zener
D17	1N 4004
D18	1N 4148
D19	1N 4148
D20	15 V Zener
D21	1N 4004
D22	1N 4148
D23	1N 4148
D24	1N 4148
D25	1N 4148
D26	1N 4004
D27	1N 4004
D28	BYW 96E
D29	BYW 96E
D30	1N 5404
D31	1N 5404
D32	BZX85C100

D33	BZX85C100
D34	BZX85C100
D35	BZX85C100

Transistors

Q1	BC 549C matched
Q2	BC 549C matched
Q3	BC 547
Q4	BC 557
Q5	BC 557
Q6	MPSA 42
Q7	MPSA 42
Q8	BC 557
Q9	BC 557
Q10	BC 547
Q11	BC 557
Q12	BC 547
Q13	BC 557
Q14	BC 547
Q15	BC 547
Q16	BC 547
Q17	BC 547
Q18	BC 557
Q19	BC 557
Q20	BC 547
Q21	BC 547
Q22	MJE 350
Q23	MJE 350
Q24	MJE 340
Q25*	BD329
Q26	MJL 21194
Q27	-
Q27a	MJL 21194
Q28	MJL 21194
Q28a	MJL 21194
Q29	MJE 350
Q30	MJE 340
Q31	MJL 21193
Q32	MJL 21193
Q32a	MJL 21193
Q33	MJL 21193
Q33a	-

Inductors

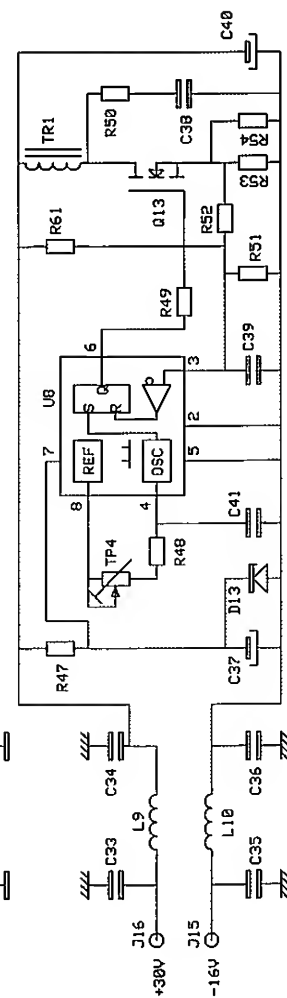
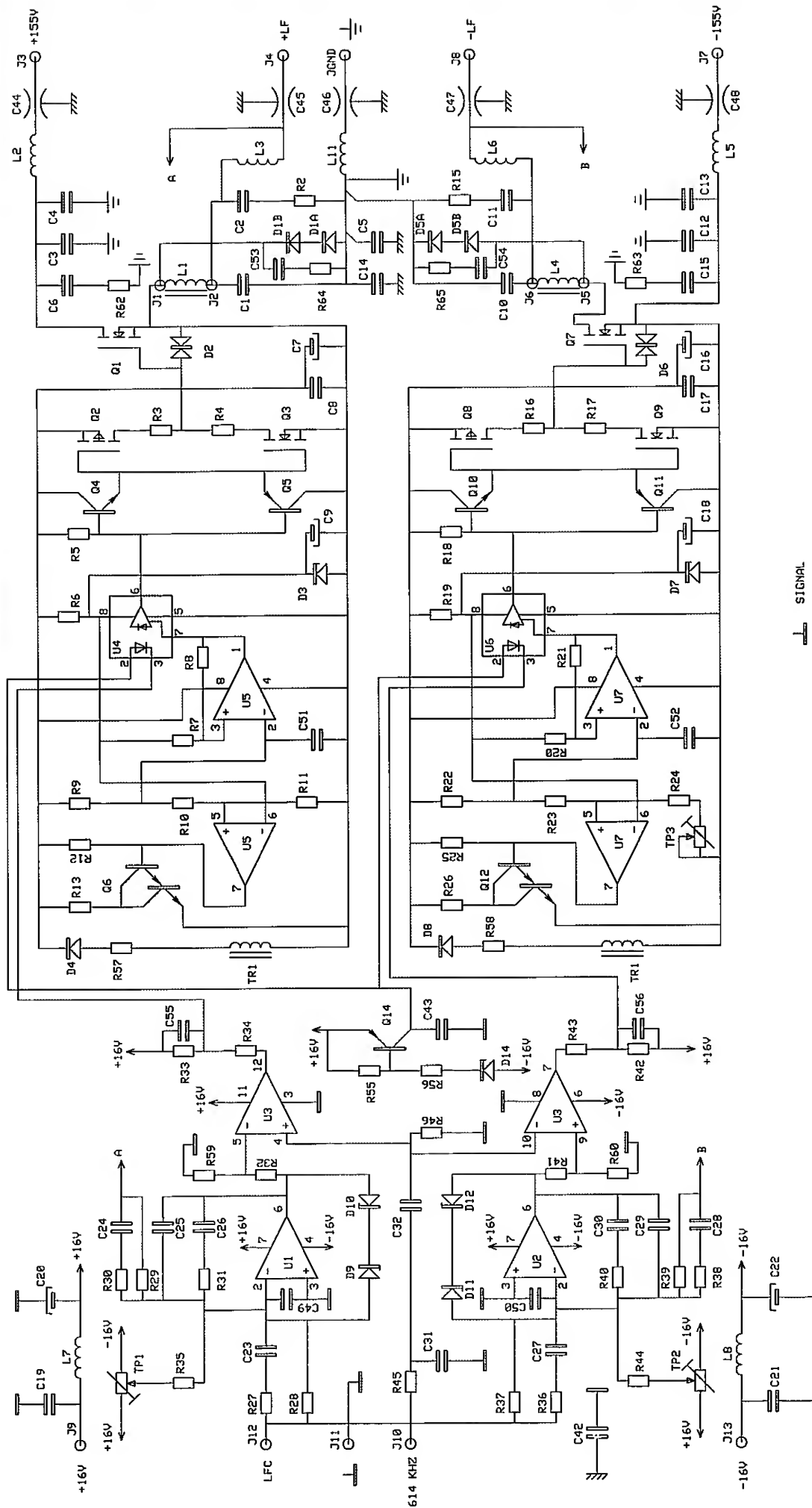
L1	9.5 μ H (2 core)
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Switches

S1	SPPJ3 Alps
S2	Dipfix Siemens

* Until 9801

R35	750 Ω 1%
Q25	MJE 340

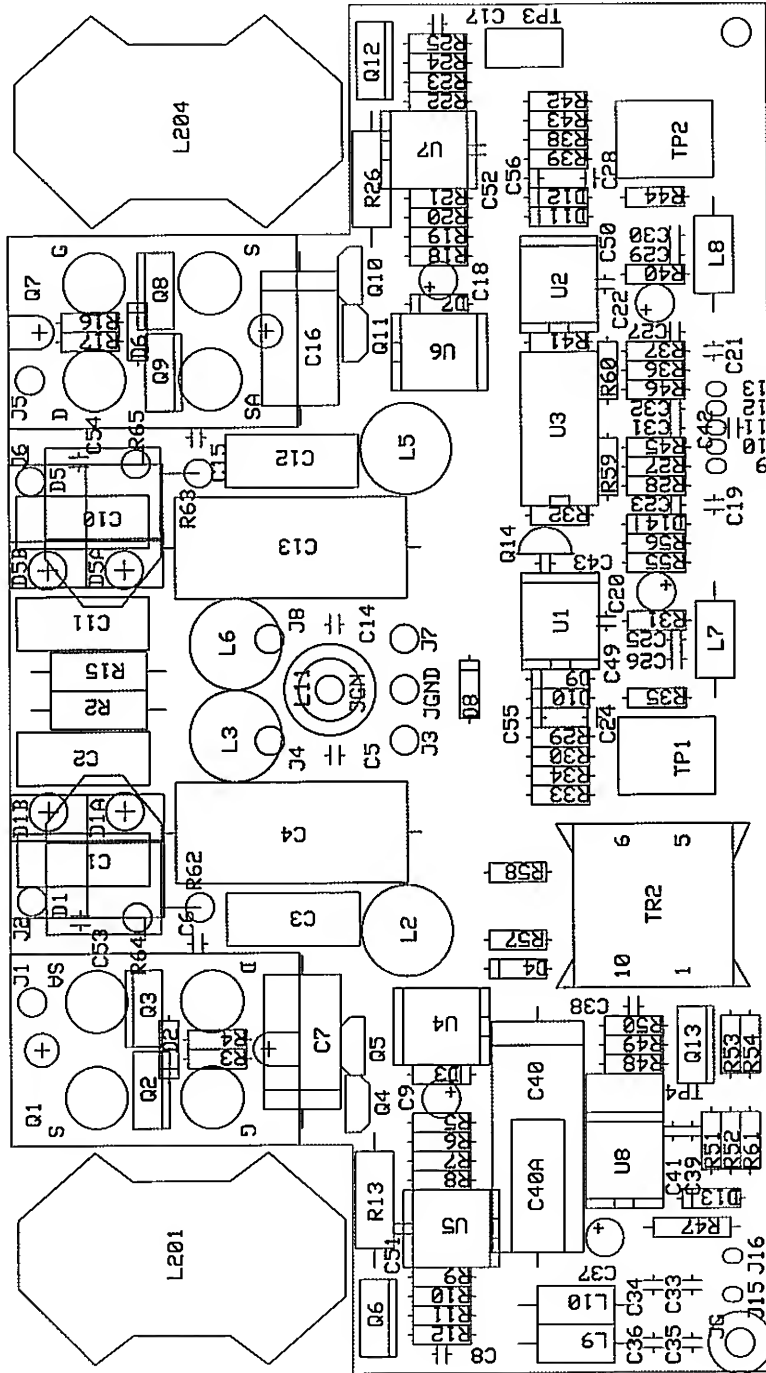


SIGNAL

POWER

ISSN 0013-788X

DESIGN K. A	DRAWN K. A	CHECKED	HF-AMPLIFIER	REPLACES % 08 20	REPLACED BY
LABGRUPPEN KUNGSBACKA SWEDEN			LAB 2002 4000	DATE 99 09 18	PAGE
				DRAWING NO	4KHf



DESIGN	DRAWN	CHECKED	HF AMPLIFIER		REPLACES	REPLACED BY
K.A	K.A					
LABGRUPPEN KUNGSBACKA SWEDEN			LAB2002 LAB4000		DATE	PAGE
					99 09 18	
					DRAWING NO	4KHFR1-P

LAB 4000

HF-AMPLIFIER

Component-list

Resistors

R1	-
R2	2,2 Ω 2W on legs
R3	4.7 Ω
R4	1 Ω 1W on legs
R5	680 Ω
R6	47 Ω
R7	2.2 k Ω 1%
R8	22 k Ω
R9	820 Ω
R10	47 Ω
R11	2.2 k Ω 1%
R12	4.7 k Ω 1%
R13	15 Ω 6W on legs
R14	-
R15	2,2 Ω 2W on legs
R16	4.7 Ω
R17	1 Ω 1W on legs
R18	680 Ω
R19	47 Ω
R20	2.2 k Ω 1%
R21	22 k Ω
R22	820 Ω
R23	47 Ω
R24	1.8 k Ω 1%
R25	4.7 k Ω 1%
R26	15 Ω 6W on legs
R27	1,5 k Ω 1%
R28	1.8 k Ω 1%
R29	27 k Ω 1%
R30	2,2 k Ω 1%
R31	6,8 k Ω 1%
R32	4.7 k Ω
R33	330 Ω
R34	1.2 k Ω
R35	56 k Ω 1%
R36	1,5 k Ω 1%
R37	1.8 k Ω 1%
R38	2,2 k Ω 1%
R39	27 k Ω 1%
R40	6,8 k Ω 1%
R41	4.7 k Ω 1%
R42	330 Ω
R43	1.2 k Ω
R44	56 k Ω 1%
R45	2.2 k Ω 1%
R46	2.2 k Ω 1%
R47	1,2 k Ω 3W
R48	12 k Ω
R49	47 Ω
R50	27 Ω 1% on legs
R51	1 k Ω 1%
R52	1 k Ω 1%

R53	2.2 Ω
R54	2.2 Ω
R55	2.2 k Ω 1%
R56	2.2 k Ω 1%
R57	1 Ω 1W on legs
R58	1 Ω 1W on legs
R59	2.2 k Ω 1%
R60	2.2 k Ω 1%
R61	120 k Ω 1%
R62	2.2 Ω 2W on legs
R63	2.2 Ω 2W on legs
R64	2.2 Ω 2W on legs
R65	2.2 Ω 2W on legs

Trim potentiometers

TP1	25 k Ω
TP2	25 k Ω
TP3	1 k Ω
TP4	10 k Ω

Capacitors

C1	0.33 μ F 250V
C2	0.33 μ F 250V
C3	0.33 μ F 250V
C4	4.7 μ F 160V
C5	1 μ F 63V
C6	4,7 nF 200V NP0
C7	470 μ F 10V
C8	0.1 μ F 63V
C9	10 μ F 50V
C10	0.33 μ F 250V
C11	0.33 μ F 250V
C12	0.33 μ F 250V
C13	4.7 μ F 160V
C14	1 μ F 63V
C15	4,7 nF 200V NP0
C16	470 μ F 10V
C17	0.1 μ F 63V
C18	10 μ F 50V
C19	0.1 μ F 63V
C20	10 μ F 50V
C21	0.1 μ F 63V
C22	10 μ F 50V
C23	2,2 nF 5%
C24	100 pF 5%
C25	39 pF 5%
C26	270 pF 5%
C27	2,2 nF 5%
C28	100 pF 5%
C29	39 pF 5%
C30	270 pF 5%
C31	68 pF

C32	1 nF
C33	0.1 μ F 63V
C34	0.1 μ F 63V
C35	0.1 μ F 63V
C36	0.1 μ F 63V
C37	10 μ F 50V
C38	1 nF/100V/5/NP0
C39	220 pF
C40	2,2 μ F 100V
C41	1 nF NP0
C42	0.1 μ F 63V ker
C43	-
C44	1.5 nF feed through
C45	1.5 nF feed through
C46	1.5 nF feed through
C47	1.5 nF feed through
C48	1.5 nF feed through
C49	220 pF
C50	220 pF
C51	1 nF
C52	1 nF
C53	470 pF 200V NP0
C54	470 pF 200V NP0

Diodes

D1a	BYW 81PI200
D1b	BYW 81PI200
D2	BZW 06P15B
D3	5.6V Zener 2%
D4	BYV 100-100
D5a	BYW 81PI200
D5b	BYW 81PI200
D6	BZW 06P15B
D7	5.6V Zener 2%
D8	BYV 100-100
D9	12V Zener
D10	12V Zener
D11	12V Zener
D12	12V Zener
D13	18V Zener 1.3W
D14	27V Zener

Transistors

Q1	IXFN 73N30
Q2	MTP2955V
Q3	BUZ 71
Q4	ZTX 650
Q5	ZTX 750
Q6	Tip 120

Q7	IXFN 73N30
Q8	MTP2955V
Q9	BUZ 71
Q10	ZTX 650
Q11	ZTX 750
Q12	Tip 120
Q13	IRF 730
Q14	BC 557

Integrated circuits

U1	LM 318
U2	LM 318
U3	LM 319
U4	HCPL 2400
U5	LM 393
U6	HCPL 2400
U7	LM 393
U8	UC 3843

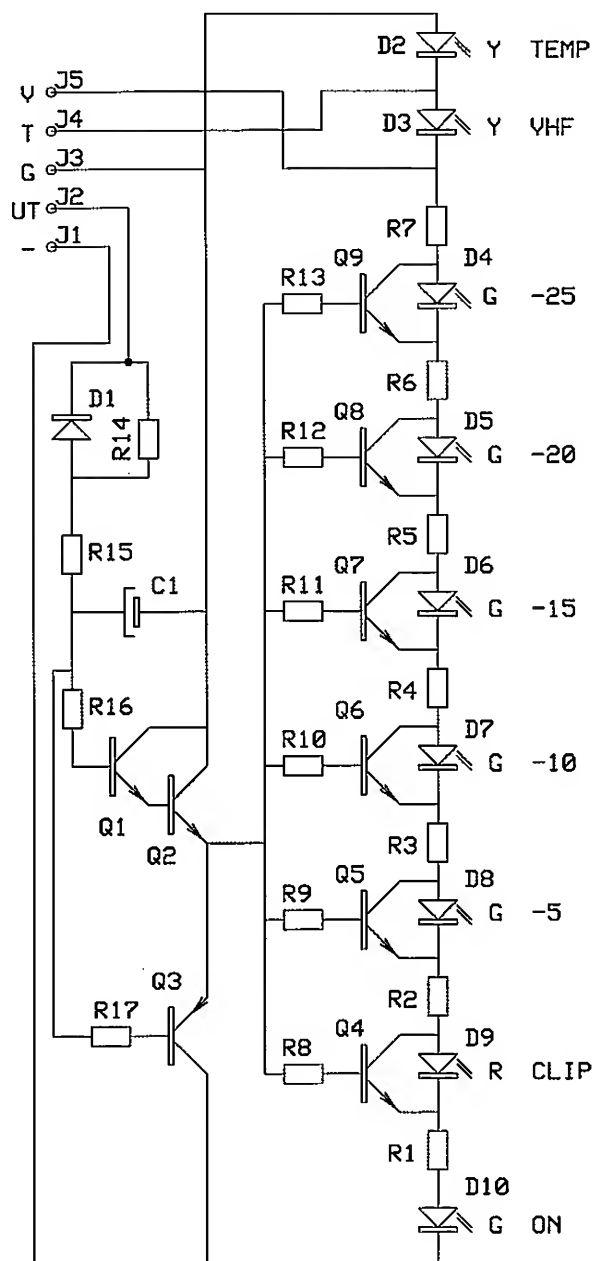
Inductors

L1	14 μ H
L2	1 μ H
L3	1 μ H
L4	14 μ H
L5	1 μ H
L6	1 μ H
L7	47 μ H
L8	47 μ H
L9	47 μ H
L10	47 μ H
L11	1 μ H

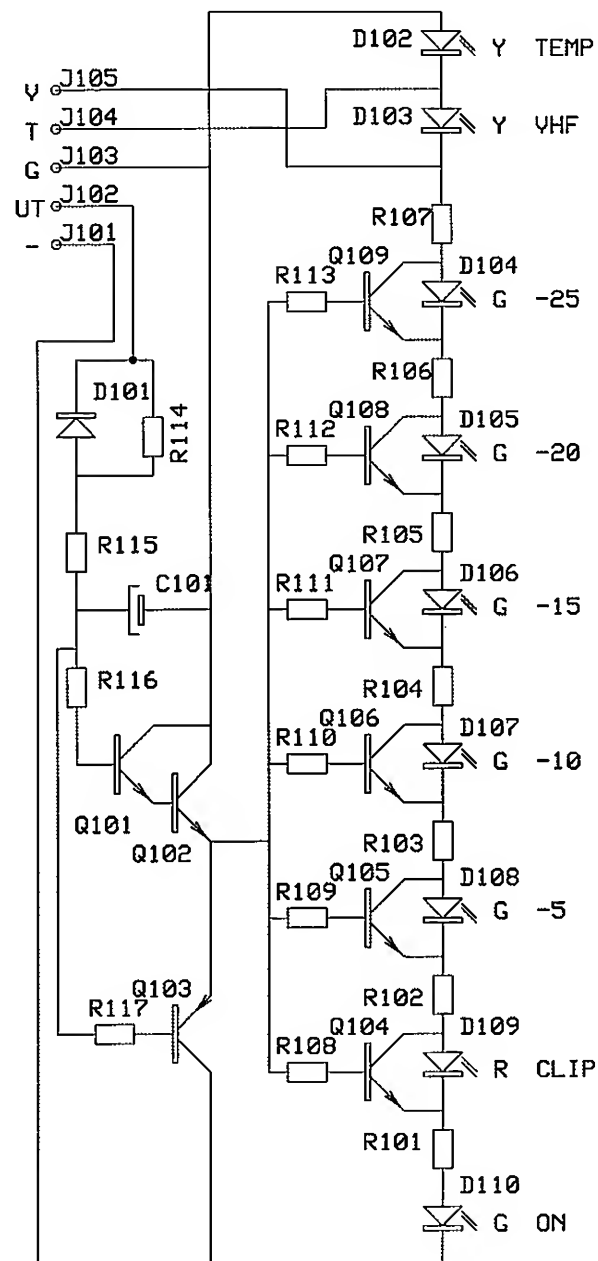
Transformers

TR1	EF20 N27
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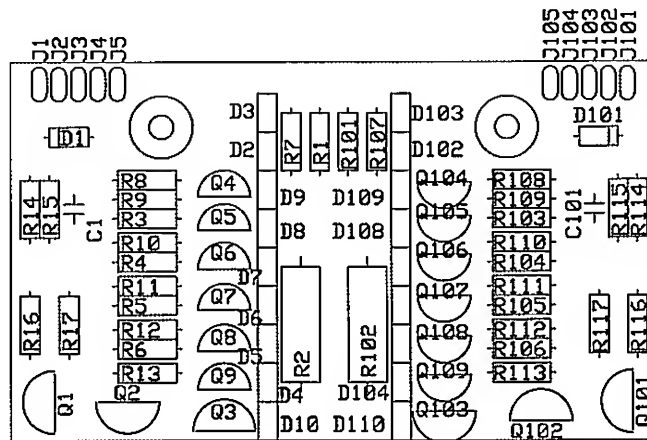
CHA



CHB



DESIGN K.A	DRAWN K.A	CHECKED	LED.DISPLAY	REPLACES	REPLACED BY
LABGRUPPEN			LAB500 1000 1300	DATE 90 12 01	PAGE
KUNGSBACKA SWEDEN			1600 2000 4000	DRAWING NO	2KLED



DESIGN K.A	DRAWN K.A	CHECKED	LED DISPLAY	REPLACES	REPLACED BY
LABGRUPPEN KUNGSBACKA SWEDEN			LAB500 1000 1300 1600 2000 4000	DATE 99 09 18	PAGE
				DRAWING NO	LEDRA-P

LAB 500 – 2002C

LED DISPLAY

Component-list

Channel A
(Ch. B add 100)

Resistors

R1 see below
R2 2.7 k Ω 3W
R3 1.2 k Ω 1W
R4 680 Ω
R5 330 Ω
R6 120 Ω
R7 220 Ω
R8 33 k Ω
R9 33 k Ω
R10 33 k Ω
R11 33 k Ω
R12 33 k Ω
R13 33 k Ω
R14 33 k Ω
R15 100 Ω 1%
R16 2.7 k Ω
R17 2.7 k Ω

Capacitors

C1 4.7 μ F 100V

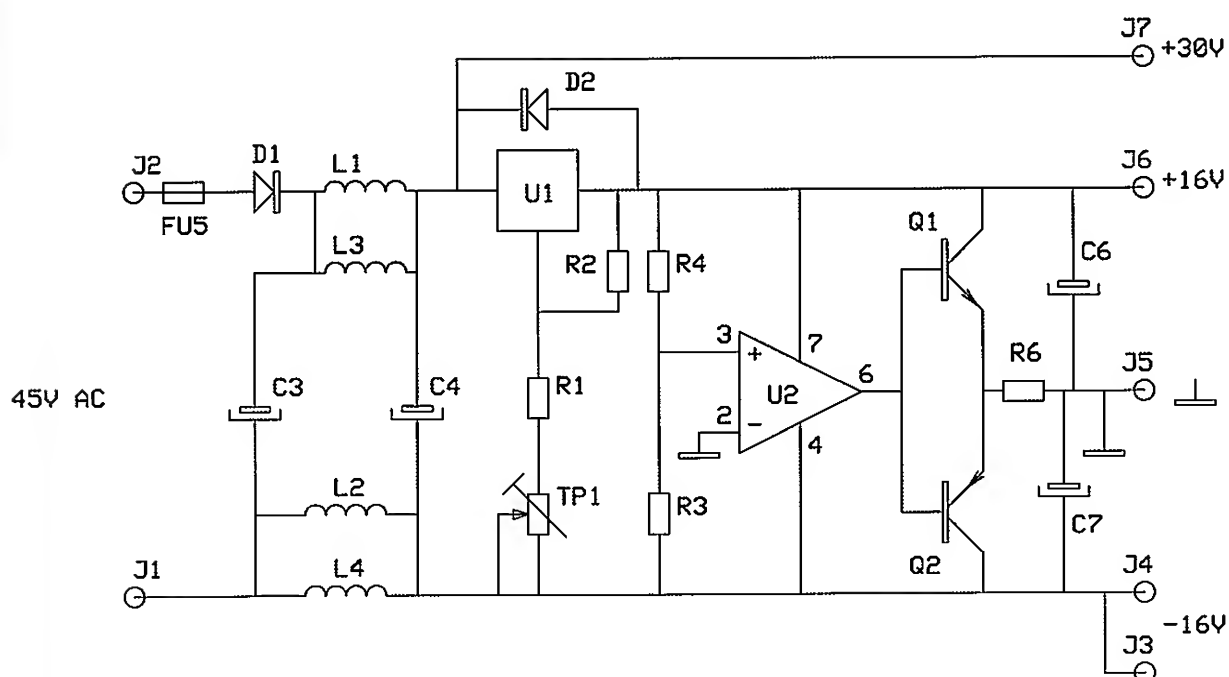
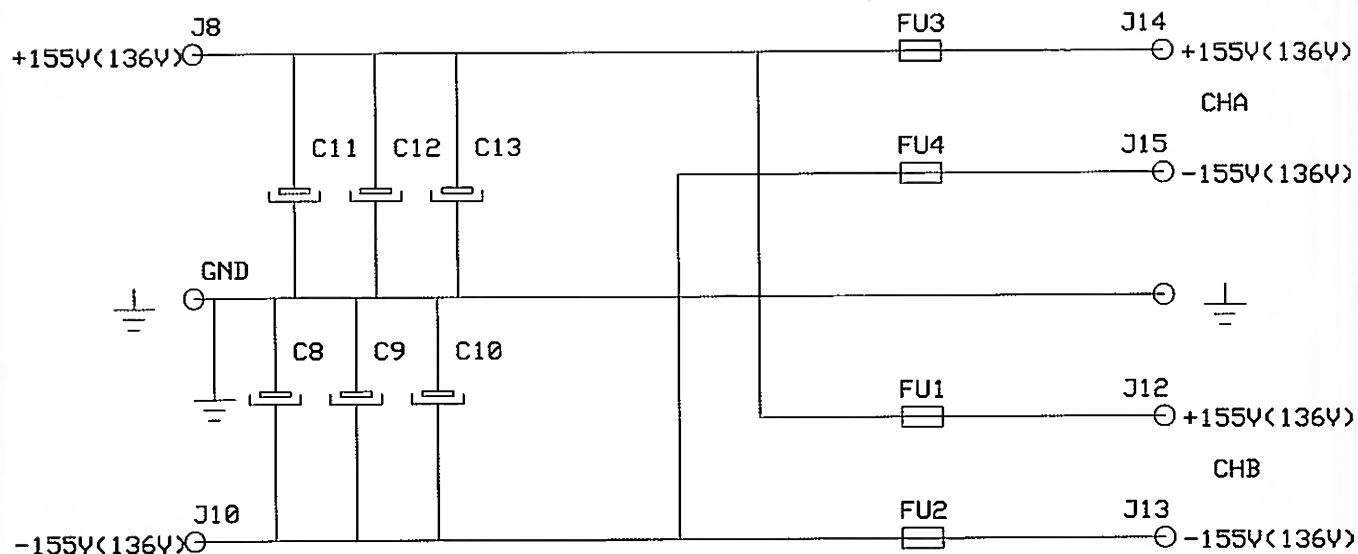
Diods

D1 1N 4004
D2 Led Y
D3 Led Y
D4 Led G
D5 Led G
D6 Led G
D7 Led G
D8 Led G
D9 Led R
D10 Led G

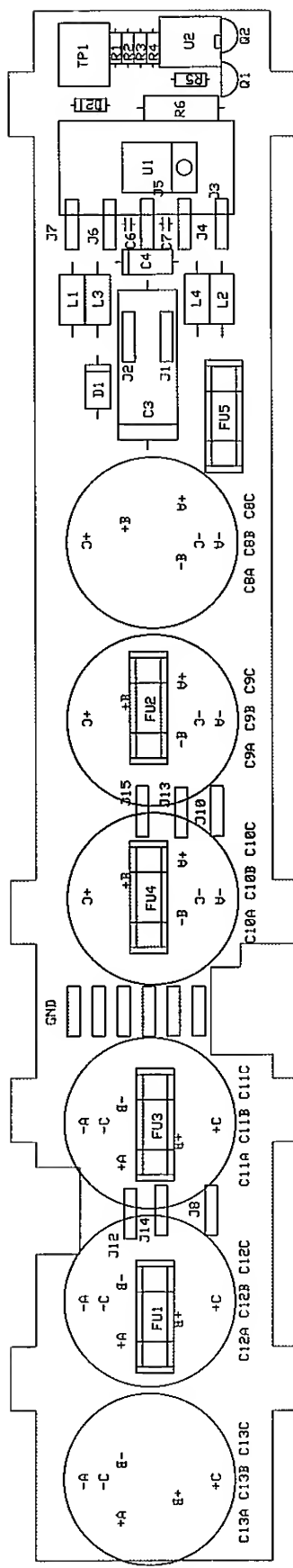
Transistors

Q1 MPSA 42
Q2 MPSA 42
Q3 MPSA 92
Q4 BC 547
Q5 BC 547
Q6 BC 547
Q7 BC 547
Q8 BC 547
Q9 BC 547

	500	1000	1300C	1600	2000
R1	1,5 k Ω	820 Ω	680 Ω	680 Ω	680 Ω 1% long legs



DESIGN K.A	DRAWN K.A	CHECKED	FUSE-BOARD VOLTAGESTABB.-BOARD	REPLACES	REPLACED BY
LABGRUPPEN KUNGSBACKA SWEDEN			LAB 2002 4000	DATE 96 08 01	PAGE
				DRAWING NO	4KFU



DESIGN K.A	DRAWN K.A	CHECKED	FUSE BOARD, VOLTAGE STABB. BOARD	REPLACES	REPLACED BY
LABGRUPPEN KUNGSBACKA SWEDEN			LAB2000 2002 4000	DATE 99 09 18	PAGE
				DRAWING NO	2KFUC-P

LAB 2002 4000

FUSE, VOLTAGESTABB. BOARD

component-list

Resistors

R1 5.6 k Ω
 R2 270 Ω
 R3 10 k Ω 1%
 R4 10 k Ω 1%
 R5 1 k Ω
 R6 150 Ω 3W

Trim potentiometers

TP1 2.5 k Ω

Capacitors

C1 -
 C2 -
 C3 470 μ F 100V (ASM021)
 C4 22 μ F 100V (ASM021)
 C5 -
 C6 22 μ F 50V
 C7 22 μ F 50V
 C8 2200 μ F 160V
 C9 2200 μ F 160V
 C10 2200 μ F 160V
 C11 2200 μ F 160V
 C12 2200 μ F 160V
 C13 2200 μ F 160V

Diodes

D1 BYW 98-200
 D2 1N 4004

Transistors

Q1 BC 337
 Q2 BC 327

Integrated circuits

U1 LM 317
 U2 UA 741

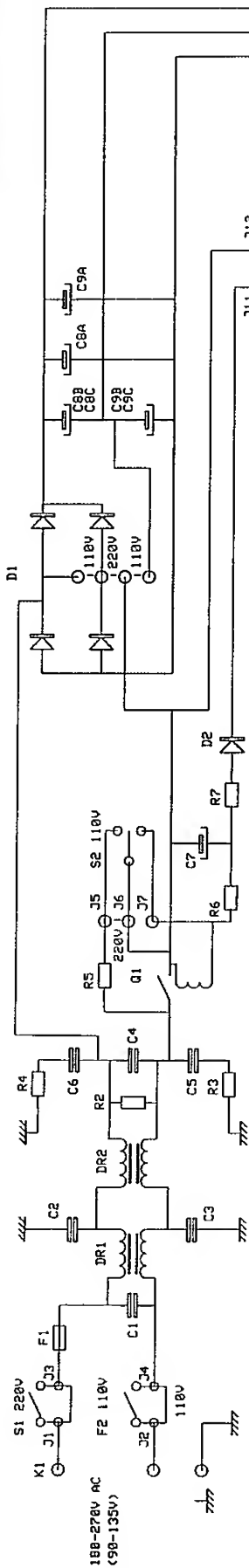
Fuses

FU1 F 15A
 FU2 F 15A
 FU3 F 15A
 FU4 F 15A

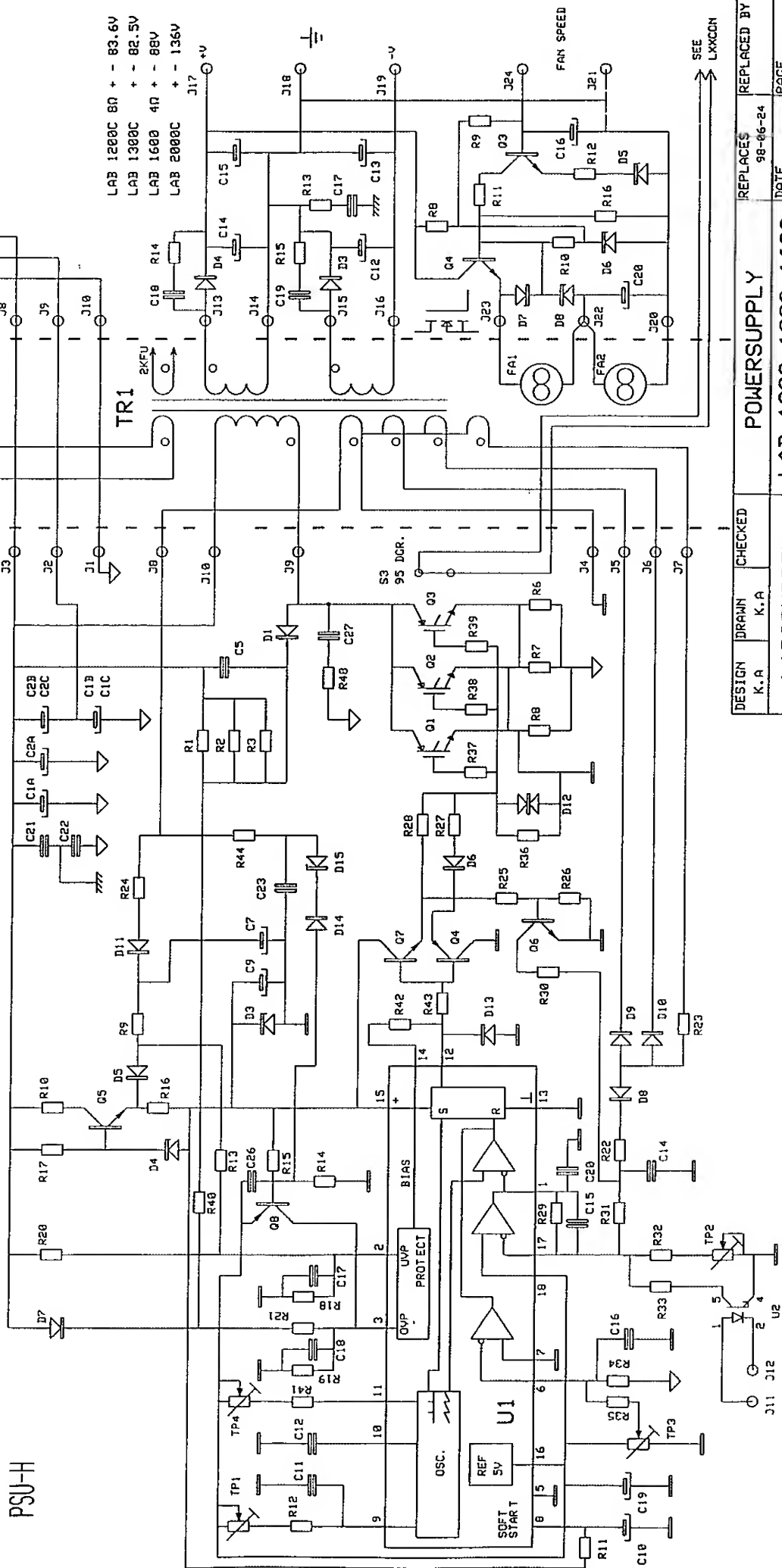
Inductors

L1 47 μ H
 L2 47 μ H
 L3 47 μ H
 L4 47 μ H

PSU-G



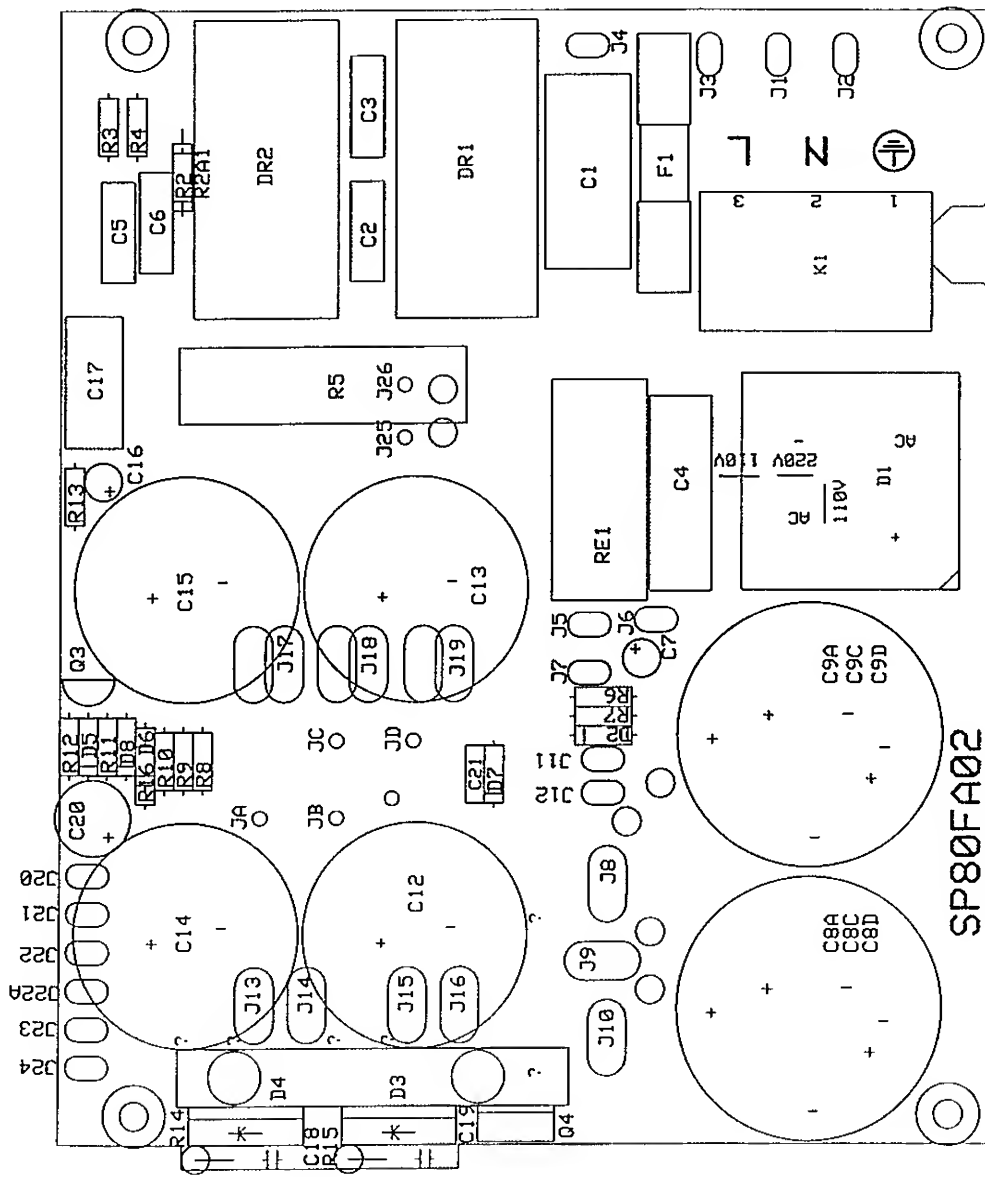
PSU-H



— SIGNAL
 — POWER LF
 — POWER PSU
 — CHASSI

LAB 1200C 80 + - 83.6V
 LAB 1300C + - 82.5V
 LAB 1600 40 + - 88V
 LAB 2000C + - 135V

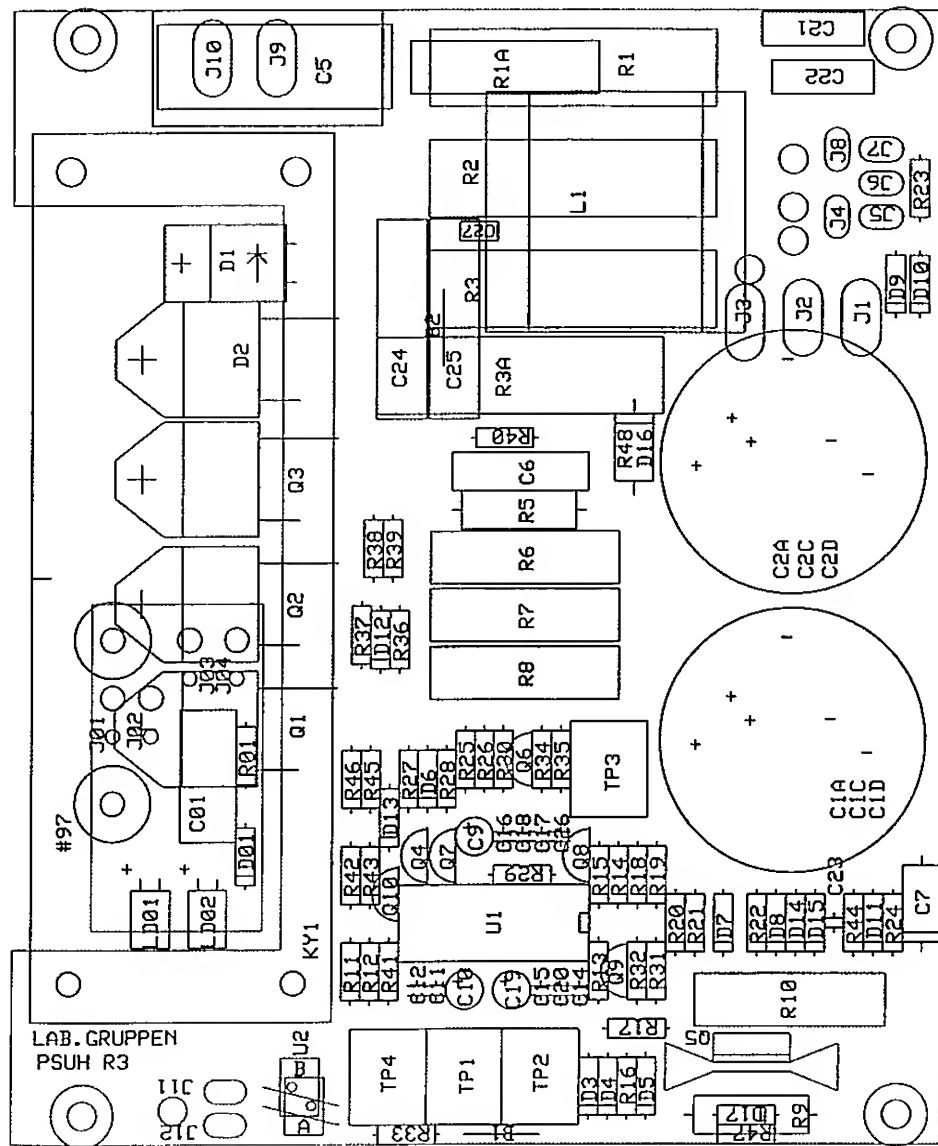
DESIGN	DRAWN	CHECKED	POWER SUPPLY	REPLACES	REPLACED BY
K.A	K.A		LAB 1200 1300 1600	98-06-24	
LABGRUPPEN				DATE	PAGE
				01-03-01	
				REVISION NO	



4 rectangles in milling type 1 = hole plated

DESIGN K.A	DRAWN K.A	CHECKED	POWER SUPPLY SP80FA	REPLACES 01 04 13	REPLACED BY
LABGRUPPEN KUNGSBACKA SWEDEN			LAB 1200 1300 1600 2000C 2002 4000 PSU48	DATE 01 05 04	PAGE
				DRAWING NO	SP80FA02-P

LAB 1200 1300 1600
2000C 2002 4000 PSU48



DESIGN K.A	DRAWN K.A	CHECKED	POWER SUPPLY H	REPLACES 99 09 18	REPLACED BY
LABGRUPPEN			LAB 1200 1300 1600	DATE 00 03 02	PAGE
KUNGSBACKA SWEDEN			2000C 2002 4000 PSU48	DRAWING NO	PSUHR3-P

POWER SUPPLY, BOARD PSUG

component-list

Resistors

R1-
 R2 1 M Ω 1%
 R3 33 Ω
 R4 33 Ω
 R5# 47 Ω 9W
 R6 33 Ω
 R7 2.2 Ω 1W
 R8 See below
 R9 See below
 R10 See below
 R11 See below
 R12 See below
 R13 4.7 Ω
 R14 See below
 R15 See below
 R16 See below

Capacitors

C1 0.47 μ F
 C2# 1.5 nF Y
 C3# 1.5 nF Y
 C4 0.22 μ F
 C5# 1.5 nF Y
 C6# 1.5 nF Y
 C7 100 μ F 50V
 C8a# See below
 C9a# See below

C12 See below
 C13 See below
 C14 See below
 C15 See below
 C16 22 μ F 16V
 C17 2.2 μ F 63V
 C18 See below
 C19 See below
 C20 See below
 C21 See below

Diodes

D1 600V 35A
 D2 BYW26C
 D3 STTB3006PI
 D4 STTB3006PI
 D5 5.6V Zener
 D6 See below
 D7 See below
 D8 See below

Transistors

Q3 BC 546
 Q4 See below

Relays

RE1 FEME MZF 0014816

Fuses

FU1 See below

Coils

DR1# See below
 DR2# See below

Switches

S1# See below
 S2# See below
 S3 Comepa 4JT95 ARIUI 95°C

Relays

RE1 FEME MZF 0014816

Socket

K1 MKDSP10/3-10,16

110V AC

R5 22 Ω 9W
 C2 2,2 nF Y
 C3 2,2 nF Y
 C5 2,2 nF Y
 C6 2,2 nF Y

* Until 9708
 Q4 BDX53F
 D7 -
 D8 -

POWER SUPPLY, BOARD PSUG

	LAB 1200C	LAB 1300C	LAB 1600	LAB 2000C	LAB 4000	PSU48-8
R8	4.7 k Ω 1%	Jumper	8.2 k Ω 1%	Jumper	27 k Ω 1% long leg	4.7 k Ω 1%
R9	1 M Ω	470 k Ω	150 k Ω	390 k Ω	180 k Ω 1%	470 k Ω
R10	39 k Ω 1%	4.7 k Ω 1% long leg	39 k Ω 1%	47 k Ω 1%	39 k Ω 1%	10 k Ω 1%
R11	18 k Ω 1%	1.8 k Ω	18 k Ω 1%	6.8 k Ω	18 k Ω 1%	4.7 k Ω 1%
R12	4.7 k Ω 1%	Jumper	4.7 k Ω	1.8 k Ω	4.7 k Ω 1%	Jumper
R14	2.2 Ω 2W	-	2.2 Ω 2W	-	-	-
R15	2.2 Ω 2W	-	2.2 Ω 2W	-	-	-
R16	-	18 k Ω 1%	-	39 k Ω 1%	-	-
C8a	220uF 385V	220uF 385V	220uF 385V	220uF 385V		220uF 385V
C9a	220uF 385V	220uF 385V	220uF 385V	220uF 385V		220uF 385V
C8b	-	-	-	-	1500 uF 200V	-
C9b	-	-	-	-	1500 uF 200V	-
C12	3900 uF 100V	3900 uF 100V	3900 uF 100V	1800 uF 160V	1800 uF 160V	3900 uF 100V
C13	3900 uF 100V	3900 uF 100V	3900 uF 100V	1800 uF 160V	1800 uF 160V	3900 uF 100V
C14	3900 uF 100V	3900 uF 100V	3900 uF 100V	1800 uF 160V	1800 uF 160V	3900 uF 100V
C15	3900 uF 100V	3900 uF 100V	3900 uF 100V	1800 uF 160V	1800 uF 160V	3900 uF 100V
C18	4.7 nF 400V	-	4.7 nF 400V	-	-	-
C19	4.7 nF 400V	-	4.7 nF 400V	-	-	-
C20	100 uF 50V	100 uF 50V	100 uF 50V	100 uF 50V	100 uF 50V	-
C21	-	-	-	680 pF/400V	680 pF/400V	-
D6	62 V \pm 2% Zener	-	62 V \pm 2% Zener	-	62 V \pm 2% Zener	27V Zener
D7	-	-	-	15V Zener	15V Zener	-
D8	-	-	-	39V \pm 2% Zener	39V \pm 2% Zener	-
Q4	TIP132	TIP41	TIP132	*IRF730	*IRF730	BDX53F
F1	T10AH250V	T8AH250V	T10AH250V	T10AH250V	T15AH250V	T10AH250V
DR1	2.7mH 8A 220V	2.7mH 8A 220V	2.7mH 8A 220V	2.7mH 8A 220V	1.4mH 16A 110V	2.7mH 8A 220V
DR2	2.7mH 8A 220V	2.7mH 8A 220V	2.7mH 8A 220V	2.7mH 8A 220V	1.4mH 16A 110V	2.7mH 8A 220V
S1	8550VB	8550VB	8550VB	8550VB	Jumper	8550VB
S2	-	-	-	-	H8610VBBB	-
B1	JB-JC, D1,2	-	-	-	-	-
B2	-	-	-	-	-	JA-JB, D1,2
B3	-	-	-	-	-	JC-JD, D1,2
B4	J5-J6	J5-J6	J5-J6	J5-J6	-	J5-J6
B5#	Rectifier 220V	Rectifier 220V	Rectifier 220V	Rectifier 220V	Rectifier 220V	Rectifier 220V

110V

C8b#	1500 uF 200V	1500 uF 200V	1500 uF 200V	1500 uF 200V	-	1500 uF 200V
C9b#	1500 uF 200V	1500 uF 200V	1500 uF 200V	1500 uF 200V	-	1500 uF 200V
C8d#	-	-	-	-	2200 uF 200V	-
C9d#	-	-	-	-	2200 uF 200V	-
F1#	T20A	T20A	T20A	T20A	T30A	T20A
DR1#	1.4mH16A110V	1.4mH16A110V	1.4mH16A110V	1.4mH16A110V	1.4mH25A110V	1.4mH16A110V
DR2#	1.4mH25A110V	1.4mH16A110V	1.4mH16A110V	1.4mH16A110V	1.4mH25A110V	1.4mH16A110V
S1	Jumper	Jumper	Jumper	Jumper	Jumper	Jumper
S2#	H8610VBBB	H8610VBBB	H8610VBBB	H8610VBBB	H8610VBBB	H8610VBBB
B5	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V
B6	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V

POWER SUPPLY, BOARD PSUH

component-list

Resistors

R1 See below
 R2 See below
 R3 See below
 R4 -
 R5 See below
 R6 0.1 Ω 4W
 R7 0.1 Ω 4W
 R8 0.1 Ω 4W
 R9 See below
 R10 4.7 k Ω 5W
 R11 680 k Ω 5%
 R12 33 k Ω 1%
 R13 100 k Ω 1%
 R14 10 k Ω 1%
 R15 18 k Ω 1%
 R16 180 Ω 1%
 R17 120 k Ω 2W
 R18# 8.2 k Ω 1% (110V see below)
 R19 See below
 R20 432 k Ω 1% highvolt
 R21 750 k Ω 1%
 R22 4.7 Ω
 R23 See below
 R24 4.7 Ω
 R25 15 k Ω 1%
 R26 1 k Ω 1%
 R27 See below
 R28 82 Ω
 R29 4.7 M Ω
 R30 See below
 R31 220 k Ω 1%
 R32 See below
 R33 See below
 R34 See below
 R35 See below
 R36 15 k Ω 1%
 R37 See below
 R38 See below
 R39 See below
 R40 See below
 R41 18 k Ω 1%
 R42* -
 R43* Jumper
 R44 See below
 R45 See below
 R46 See below
 R47 See below
 R48 See Below

Capacitors

C1a# See below
 C2a# See below
 C5 0.68 μ F 250V
 C6 -
 C7 10 μ F 63V
 C8 -
 C9 10 μ F 50V
 C10 22 μ F 50V
 C11* 470 pF NPO
 C12 1 nF
 C13 -
 C14 10 nF
 C15 See below
 C16 330 pF
 C17 -
 C18 1 nF
 C19 10 μ F 50V
 C20 -
 C21# 1.5 nF Y
 C22# 1.5 nF Y
 C23 1 nF
 C24 See below
 C25 See below
 C26 1 nF
 C27 See Below

Diodes

D1 BYT 12PI 1000
 D2 See below
 D3 15V 1.3W Zener
 D4 5.6V 0.4W Zener
 D5 1N 4148
 D6 BYW 26C
 D7 1N 4004
 D8 1N 4148
 D9 1N 4148
 D10 1N 4148
 D11 BYW 26C
 D12 BZW 06P15B
 D13 BAT 85
 D14 1N 4148
 D15 See below
 D16 See below
 D17 See below

Trim potentiometers

TP1 10 k Ω
 TP2 25 k Ω
 TP3 10 k Ω
 TP4* 15 k Ω Resistor

Integrated circuits

U1 UC 3851 alt. UC 3841
 U2 See below

Transistors

Q1 See below
 Q2 See below
 Q3 See below
 Q4 BC 327
 Q5 TIP 50
 Q6 BC 547
 Q7* Jumper b-e
 Q8 BC 557
 Q9 See below
 Q10 See below

Switches

S2 Temp switch 95°

Inductors

L1 See below

Jumpers

B1 See below
 B2 See below

110V

C1b See below
 C2b See below
 C21 2,2nF Y
 C22 2,2nF Y
 R18 10k Ω 1%

* UC3841

R42 4.7 k Ω
 R43 82 Ω
 TP4 10 k Ω
 C11 1 nF
 Q7 BC 337

POWER SUPPLY, BOARD PSUH

	LAB 1200C	LAB 1300C	LAB 1600	LAB 2000C	LAB 4000	PSU 48-8
R1	18 k Ω 9W	18 k Ω 9W	18 k Ω 9W	18 k Ω 9W	33 k Ω 9W	18 k Ω 9W
R2	18 k Ω 9W	18 k Ω 9W	18 k Ω 9W	18 k Ω 9W	-	18 k Ω 9W
R3	18 k Ω 9W	18 k Ω 9W	18 k Ω 9W	18 k Ω 9W	-	18 k Ω 9W
R5	-	-	-	-	330 Ω 2W	-
R9	1.5 k Ω 2W	1.5 k Ω 2W	1.5 k Ω 2W	1.5 k Ω 2W	1 k Ω 3W	1.5 k Ω 2W
R19	5.62 k Ω 1%	5.62 k Ω 1%	5.62 k Ω 1%	5.62 k Ω 1%	5.9 k Ω 1%	5.62 k Ω 1%
R23	8,2 k Ω 1%	6.8 k Ω 1%	6.8 k Ω 1%	6.8 k Ω 1%	6.8 k Ω 1%	10 k Ω 1%
R27	4.7 Ω	4.7 Ω	4.7 Ω	4.7 Ω	jumper	4.7 Ω
R30	56 k Ω 1%	56 k Ω 1%	56 k Ω 1%	56 k Ω 1%	180 k Ω 1%	56 k Ω 1%
R32	133 k Ω 1%	88.7 k Ω 1%	169 k Ω 1%	88.7 k Ω 1%	88.7 k Ω 1%	-
R33	270 k Ω 1%	-	330 k Ω 1%	-	1 k Ω 1%	-
R34	2,2 k Ω 1%	2,0 k Ω 1%	2,2 k Ω 1%	2,2 k Ω 1%	2,4 k Ω 1%	-
R35	4.7 k Ω 1%	4.7 k Ω 1%	4.7 k Ω 1%	4.7 k Ω 1%	3,3 k Ω 1%	4.7 k Ω 1%
R37	4.7 Ω	4.7 Ω	4.7 Ω	4.7 Ω	2.2 Ω	-
R38	4.7 Ω	4.7 Ω	4.7 Ω	4.7 Ω	2.2 Ω	4.7 Ω
R39	4.7 Ω	4.7 Ω	4.7 Ω	4.7 Ω	2.2 Ω	4.7 Ω
R40	1 M Ω 1%	1 M Ω 1%	1 M Ω 1%	1 M Ω 1%	1,2 M Ω 1%	1 M Ω 1%
R44	470 Ω	470 Ω	470 Ω	470 Ω	560 Ω	470 Ω
R45	-	-	-	-	698 Ω 1%	-
R46	-	-	-	-	196 Ω 1%	-
R47	-	-	-	-	820 Ω	-
R48	2,2 Ω 2W	2,2 Ω 2W	2,2 Ω 2W	2,2 Ω 2W	-	2,2 Ω 2W
C1a#	220 uF 385V	220 uF 385V	220 uF 385V	220 uF 385V	-	220 uF 385V
C2a#	220 uF 385V	220 uF 385V	220 uF 385V	220 uF 385V	-	220 uF 385V
C1b#	-	-	-	-	1500 uF 200V	-
C2b#	-	-	-	-	1500 uF 200V	-
C6	-	-	-	-	1 nF 1.5 kV	-
C15	330 pF	330 pF	330 pF	330 pF	330 pF	1 nF
C24	-	-	-	-	22 nF 1kV	-
C25	-	-	-	-	22 nF 1kV	-
C27	100pF/1600V	100pF/1600V	100pF/1600V	100pF/1600V	-	100pF/1600V
D2	-	-	-	-	STTA 1512PI	-
D15	43V 2% Zener	43V 2% Zener	39V 2% Zener	43V 2% Zener	43V 2% Zener	30V 2% Zener
D16	-	-	-	-	BYM 26E	-
D17	-	-	-	-	1N4148	-
Q1	BUP 307	BUP 307	BUP 307	BUP 307	BUP 314S	BUP 307
Q2	BUP 307	BUP 307	BUP 307	BUP 307	BUP 314S	-
Q3	BUP 307	BUP 307	BUP 307	BUP 307	BUP 314S	-
Q9	Jumper b-c	-	Jumper b-c	-	BC557	-
Q10	-	-	-	-	BC547	-
U2	PC 113	-	PC 113	-	Jumper 1-5	PC 113
U2	-	-	-	-	Jumper 2-4	-
L1	-	-	-	-	400 uH LAB	-
B1	-	-	-	-	-	jumper
B2	-	-	-	-	-	jumper
# 110V						
C1b#	1500 uF 200V	1500 uF 200V	1500 uF 200V	1500 uF 200V	-	1500 uF 200V
C2b#	1500 uF 200V	1500 uF 200V	1500 uF 200V	1500 uF 200V	-	1500 uF 200V
C1d#	-	-	-	-	2200 uF 200V	-
C2d#	-	-	-	-	2200 uF 200V	-
R18	10 k Ω 1%	10 k Ω 1%	10 k Ω 1%	10 k Ω 1%	-	-
AFS IND.						
R01	-	-	-	-	4,7 k Ω 1%	-
C01	-	-	-	-	0,1uF 400V	-
D01	-	-	-	-	1N4148	-
LD01	-	-	-	-	green 2,5x5mm	red 2,5x5mm
LD02	-	-	-	-	red 2,5x5mm	green 2,5x5mm